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Frontispiece

FIG. 1. Title page of the first edition of the "De Motu Cordis." Actual size 17.5 cm. × 13.7 cm.

WILLIAM HARVEY

BY

ARCHIBALD MALLOCH

M.D. (McGILL), M.R.C.P. (LOND.)

Librarian, N.Y. Academy of Medicine; Author of "Finch and Baines, a 17th Century Friendship."

WITH TEN FULL-PAGE PLATES AND
THREE TEXT ILLUSTRATIONS

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PREFACE

The anniversaries of three men whose work was much concerned with the vascular system have been celebrated in 1928. William Harvey was born in 1578 and his masterpiece on the movement of the heart and blood was published in 1628, Marcello Malpighi was born in the latter year, and John Hunter came into the world in 1728.

A tercentenary address delivered at a joint meeting of the Harvard Medical Society and the Boston Medical History Club held on the twenty-fourth of April at the Peter Bent Brigham Hospital gave origin to this little book. The place of meeting was well chosen for there the chairman, Dr. Harvey Cushing, and his assistants had done so much towards unravelling the mysteries of the third circulation—that of the cerebrospinal fluid.

Anyone who writes about Harvey must feel much indebted to the late Sir Norman Moore, Bart. for his life in the "Dictionary of National Biography" and the chapter on Harvey in his monumental "History of St. Bartholomew's Hospital." Sir D'Arcy Power's "William Harvey" (in the Masters of Medicine Series) remains the standard life and the author of the present book

has also made use of some of Sir D'Arcy Power's later researches into the movements of Harvey on the Continent. It is hoped that medical students, doctors, and others will welcome a sketch of the life and work of one of the greatest scientists and physicians and that they will be stimulated towards further reading of those fascinating subjects, the history of science and the biography of its great men. An attempt has been made to show how a knowledge of the circulation was painfully and slowly won in the centuries before Harvey and exactly how the latter arrived at the important conclusion that the blood moved in a circle.

The illustrations have been taken from many sources; I wish to state my indebtedness to the owners and the publishers for the use of portraits and other material. I wish to thank the staff of the Library of the New York Academy of Medicine for their kind help in the preparation of this book.

A. M.

New York, N. Y.
October, 1928.

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WILLIAM HARVEY

I

HARVEY'S EDUCATION

illiam Harvey was born at Folkestone, Kent, on the 1st of April 1578, and, as Thomas Fuller[2] quaintly put it, he was the eldest of "a weeke of sons." His father was a person of some substance who later became jurat, or alderman. If we can believe her very eulogistic epitaph, William's mother could not have been better chosen. Young Harvey was educated at the King's School, Canterbury and was no doubt well drilled in the classics, for in later years he often quoted Virgil, his favourite poet, in his

scientific writings.[1] Possibly through his bent for natural history he was nominated to a scholarship preparing one for medicine at Gonville and Caius College, Cambridge, and he may have watched dissections there. As many a young man does today, Harvey passed through the three gates of the College, that of Humility, that of Virtue and that of Honour, and obtained his B.A. in 1597.

Padua had been the greatest school of medicine for some time and, like such great men as Linacre and John Caius, Harvey went to that place which Vesalius and others had made famous. Harvey entered on his medical course in 1600. The University was governed largely by the students of the different nationalities and Harvey was chosen *concilarius* of the English "nation," an office which in 1652 John Finch said entailed being "drunk at least 40 times in the year." Was hospitality so abundant in Harvey's day? The students are remembered at Padua by tablets or stemmata upon the walls or roof of the cloisters and Harvey's and those of many other Englishmen and Scots are there. In 1593 as a tribute to Fabricius ab Aquapendente, Harvey's chief teacher, the

Fig. 2. Harvey's stemma at Padua.
(From Sir D'Arcy Power's "William Harvey," London, T. F. Unwin, 1897.)

Seignury of Venice had erected an anatomical theatre. The circular galleries with high carved oaken railings, behind which the students stood, rise in tiers almost straight to the roof and the absence of daylight adds an air of mystery to the room. The dissections under the direction of Fabricius were performed by candle light on subjects brought up through a trapdoor beneath the table. The young man and his teacher became warm friends, Harvey being stimulated most by Fabricius's discovery of the valves in the veins and his work on development. William Harvey was created M.D. on the 25th of April 1602 in the presence of several other Englishmen, some of whom made their mark later.

He returned to England in 1602 and took his Cambridge M.D. in the same year and in 1604 was admitted a candidate by examination to the Royal College of Physicians, then in Linacre's house in Knightrider Street. Harvey became a Fellow in 1607. He took a house close to St. Bartholomew's Hospital and perhaps through an introduction from Inigo Jones, the famous architect, who had been born within the precincts of the hospital, he began to work

there. In 1604 he married Elizabeth, daughter of Dr. Lancelot Browne, physician in turn to Queen Elizabeth and James I. The Harveys had no children and we know little of Mrs. Harvey except that she had a tame parrot and was "tall, of a dark complexion and somewhat severe aspect." One day the parrot died and the joke was on its mistress and especially on its master, the father of English midwifery and great embryologist, for a dissection revealed that it was not a gentleman bird as supposed, but a lady one!

Through a letter from James I, probably obtained through the influence of John Harvey, William's brother, who was footman to his Majesty, Harvey was appointed assistant physician to St. Bartholomew's Hospital in 1609. Harvey never lived within the bounds of the hospital.

II

A LUMLEIAN LECTURER—A DAY WITH HARVEY

He began to build up a practice and we know he had many patients in the higher walks of life, but he must have been continually carrying out dissections and observations upon all kinds of animals for he dissected eighty different species. On the 4th of August, 1615, he was elected Lumleian Lecturer at the College. These lectures were founded by Dr. Richard Caldwell and Lord Lumley in 1581 and are still delivered, although no longer as a long course and the subject of them is not restricted to anatomy and surgery. The whole course in Harvey's time was gone through every six years. William Harvey, then in his thirty-seventh year, began his anatomical lectures on April 16th, 17th and 18th, 1616, in the anatomical theatre adjoining Linacre's house in Knightrider Street, before about forty physicians of the College and a few laymen.

It is fortunate that his autograph notes for his lectures are preserved in the British

Museum and some of them were reproduced in facsimile with transcription by a committee of the Royal College of Physicians in 1886.[3] The writing of the title-page is in red ink and is scarcely legible. Across the top is written a phrase from the third Eclogue of Virgil, which Sir Norman Moore translates, "From God all begins: all things are full of God," an idea to which Harvey returns in his work on generation[4] where he writes of his belief in an Omnipotent Being. Below the title is written a quotation from Aristotle's "Historia animalium" in which the study of the inner parts of animals is recommended to aid one to understand the human organism, and it was just by following this advice and employing the method of comparative study that the gifted Harvey was enabled to make those extraordinary discoveries in physiology and embryology.

These notes are written on both sides of about a hundred small pieces of paper. Harvey wrote an atrocious, crabbed hand and the notes are rendered still more difficult to read since the sentences are not completed and many Latin words and phrases appear in the midst of English ones. His initials WH are placed in a

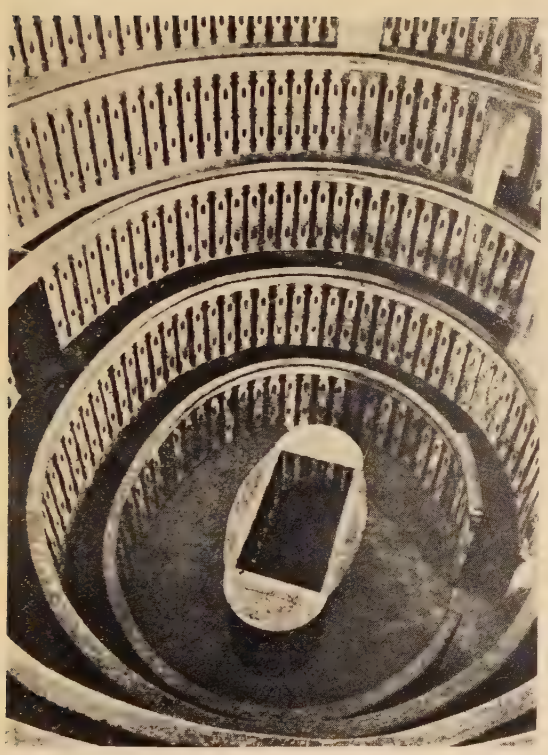

Fig. 3. The anatomical theatre of Fabricius at Padua. (From J. G. Curtis' "Harvey's Views on the Use of the Circulation of the Blood," N. Y., Columbia University Press, 1915.)

monogram, WH, before any statement which he thought peculiarly his own and a capital delta, Δ, stands for the phrase, "it is demonstrated." This precious volume of notes contains eleven rules which Harvey laid down for himself in delivering lectures; all of them are worth quoting, but I shall give six only:

2. To point out what is peculiar to the actual body which is being dissected. [In this way anomalies and also pathological lesions would not be lost sight of.]

3. To supply only by speech what cannot be shown on your own credit and "by authority."

4. To cut up as much as may be in sight of the audience.

6. Not to praise or dispraise other anatomists, for all did well, and there was some excuse for those who are in error.

8. To state things briefly and plainly, yet not letting anything pass unmentioned which can be seen.

9. Not to speak of anything which can be as well explained without the body or can be read at home.[5]

The skin, outward form of the body, the abdomen, and the thorax in their anatomical, physiological, and pathological aspects are treated of in these lectures.

Nine pages, in all, deal with the vascular system. Folio 80 verso, the now well-known page, gives in brief his enunciation of the circulation. Charles Singer[6] has translated these rather untranslatable notes as follows:

> On account of the structure of the heart, William Harvey is of the opinion that the blood is constantly passed through the lungs into the aorta, as by two clacks of a water bellows to raise water. Moreover, on account of the action of a bandage on the vessels of the arm he is of the opinion that there is a transit of blood from the arteries to the veins. It is thus demonstrated that a perpetual motion of the blood in a circle is brought about by the beat of the heart. What shall we say? Is this for the purpose of nutrition? Or is it for the better preservation of the blood and of the members by imparting heat to them, the blood by turns losing heat as it warms the members, and gaining heat from the heart?

In these notes as well as in the published writings of Harvey we can see the authors he had read. Aristotle and Galen are the most frequently mentioned in the "Prelectiones." Hippocrates is quoted and it is plain that he has read Plautus, Terence, Vitruvius, Plutarch, Caesar, Cicero, Eccle-

siastes, St. Augustine, Avicenna, Averrhoes Erasistratus, Oribasius, Herophilus. He mentions Vesalius, Realdus Columbus, Fallopius, Fabricius, Bauhin, Fernel, Cardan, Benivieni, and many others. The names of Dr. Gilbert and other physicians of his time occur, also those of many of his noble or knightly patients and even members of his own family.

Harvey uses homely but refreshingly vivid figures of speech to make his points and these lecture notes form one of the most human documents I know. For instance, he compares desquamation after scarlet fever with the scaling of feather sheathes from a bird then living in the Royal collection in St. James's Park; and the succession of names for different parts of the intestine suggests the various names of the same street as you pass from St. Paul's to Leadenhall—Cheap, Poultry, and the rest. He mentions football, bear-baiting, and cockfighting, the ballet, tumblers, and rope makers and apparently a man who could "break buttons" by expanding his chest. He suggests cutting the laces of young girls whose livers are being deformed. He says "the best fashion to lep to run to doe anything [is to] stripp

to y^e^ scin"[7] and "Fashion is but copertura redundantiae dispositio fantastica"[8] in his judgment. He compares acid eructations rising up from the stomach with motions from the Lower to the Upper House of Parliament. Following the sentence "Yf I could shew what I hav seene y^t^ weare att an end between physicians et philosophers,"[9] Harvey states that the blood is rather to be regarded as the author of the liver than the liver of the blood and adds: "Anima est in sanguine,"[10] the soul or life is in the blood.

Harvey's little whalebone pointer or wand tipped with silver, used by him at his lectures, is one of the most treasured possessions in the Royal College of Physicians.

A DAY WITH HARVEY

Harvey was appointed Physician Extraordinary to James I in 1618 and later was Physician to Charles I and on terms of warm friendship with him. Sir Benjamin Ward Richardson[11] has left us what might be called "A Day in the Life of Harvey." We see him entering St. Bartholomew's Hospital, examining patients there in the large hall, riding on horseback

followed by two runners who spread out the footcloth when he alights at St. James's Palace where he visits the King. We accompany him as he rides to see his patients and when he goes to visit his merchant brothers in the City. Then we make our way back with him as far as Amen Corner to the Royal College of Physicians and here Harvey delivers a lecture. The Fellows banquet together in their common hall and we find that Harvey is on the best of terms with, and honoured by, his friends. Finally we go along with him to his house not far off and follow him into his library where he consults his favourite authors, Aristotle and Galen; and before he falls asleep in bed he reads a passage from Virgil who was his constant companion.

Benjamin Ward Richardson makes use of the following description of Harvey written by John Aubrey:

FIG. 4. Harvey's pointer or wand used at his lectures. (About 20 inches long.)
(Reproduced by permission of the Royal College of Physicians.)

He was, as all the rest of the brothers, very cholerique; and in his younger days would be apt to drawe out his dagger upon every light occasion. He was not tall, but of the lowest stature; round faced, olivaster (like wainscott) complexion; little eie, round, very black; full of spirit; his hair was black as a raven, but quite white 20 years before he died.

I do not believe that Harvey lost his temper so easily as Aubrey tells us except when a fit of gout or sciatica was upon him but believe rather that he handled his dagger playfully when conversing with others.

III

PUBLICATION OF THE BOOK ON THE CIRCULATION

In 1628 Harvey's book, "Exercitatio anatomica de motu cordis et sanguinis in animalibus," was published at Frankfurt by Wilhelm Fitzer. It is a small quarto volume of seventy-two pages plus one and a quarter of errata, but it is one of the most important medical books if not the most important one. Albrecht von Haller has called it *libellus aureus*[12] and Flourens,[13] *le plus beau livre de la physiologie*, and to us now these do not seem to be extravagant phrases.

We have seen that in 1616 in his Lumleian Lectures,[14] in the last of the nine pages dealing with the heart and blood vessels, Harvey describes the circulation of the blood. Why was it then, that his doctrine remained unpublished for twelve years? Underhill[15] in 1905 threw out the interesting suggestion that folio 80, both recto and verso of which are remarkably clean and show few alterations, was slipped into the "Prelectiones" or notes, at a later date, and thus that Harvey did not express

his view until some time after 1616. I wrote to the Keeper of Manuscripts at the British Museum and Mr. J. P. Gilson replies:

I can see no external evidence tending to show that f.80 recto is not a direct continuation of what precedes. The paper (though it has no watermark) has the appearance of being identical with the rest of the book. That the passage on the verso of f.80 [where the circulation is described] may be an after thought is however a possibility (whether probable or not must depend on internal evidence) for it does look as if written with different ink and probably another pen. But there are other cases in which variations of ink strength occur, *e.g.* at top of f.56 verso, which scarcely admit of being regarded as additions (on the other hand see 44 verso). The character of these passages would need to be investigated by an expert anatomist to form an opinion.

In the address[16] to Dr. Argent, President of the Royal College of Physicians, and his colleagues which follows the dedication, Harvey speaks of his views having already been confirmed many times "per novem et amplius annos," for nine years and more. Now this would throw the discovery back to 1619 or 1618. Huxley thought that as Harvey was a careful

FIG. 5. Harvey demonstrating to Charles I his discovery of the circulation of the blood. (From an engraving by H. Leman after R. Hannah.)

Fig. 6. W. C. Edward's engraving after Jansen's portrait of Harvey in the Royal College of Physicians, London.

writer we must believe that he did not wish to lay claim to having enunciated his complete views before that time. At any rate Harvey admits having these ideas for eight or nine years and he forms a good example of one who did not rush into print,—it is a great temptation to us all. William Osler[17] in his Harveian Oration of 1906 considered the point and said, "Perhaps it was the motive of Copernicus, who so dreaded the prejudices of mankind that for thirty years he is said to have detained in his closet the 'Treatise of Revolutions.'" Listen also to Harvey's lament:

> . . . The crowd of foolish scribblers is scarcely less than the swarms of flies in the height of summer, and threatens with their crude and flimsy productions to stifle us as with smoke.[18]

It is interesting to speculate also why the great book was printed and published at Frankfurt. I cannot find that Wilhelm Fitzer[19] ever published any other important medical or other scientific books. It is a thousand pities that it is not a very good piece of bookmaking. I have examined several copies of the book and, as others have also remarked, I have scarcely seen one of which the leaves were not badly

discoloured or foxed. There seems to have been some very poor paper used in Germany about that time, for I came across in our library a copy of Michael Potier's[20] "Philosophia pura . . . " printed at Frankfurt in 1619, octavo, and, throughout almost the whole book, the leaves, also made of poor paper, are foxed just as in Harvey's work printed nine years later. Did the Thirty Years War account for this poor quality of material? On the other hand, the paper of the first edition of Harvey[21] in English printed in London by Francis Leach, for Richard Lowndes in 1653 has remained in very good condition. Up to 1824 there were about 16 Latin, 2 English, and 1 Dutch editions; at least one other in Latin and two in English will appear in 1928.

IV

HARVEY'S PREDECESSORS

Whole books have been written about the growth of our knowledge of the circulation and here we can merely touch lightly upon the most important contributions to the subject. Hippocrates[22] (*ca.* 400 B.C.) recognized that the heart was a muscle and attributed the pulse to a movement of the blood vessels. Aristotle[23] (*fl.* 350 B.C.) held that the heart was the centre of the vascular system but for him it was also the focus of the heat of the body and the seat of intelligence. A little later Erasistratus of the Alexandrian school described the valves of the heart but he erred when he thought that the arteries contained air. Galen[24] (*fl.* 180 A.D.), Harvey calls him "the divine Galen,"[25] was the first great experimental physiologist who dared to tie an artery in two places and incise it to show that it contained no air but blood only. According to him the liver was the centre of the venous system and the blood ebbed and flowed in tides from it in the veins carrying the *natural spirits* which were formed in the liver from the chyme brought to it.

Part of the blood then passed through the right heart and the pulmonary artery to the lungs to nourish them and here the "fumes or sooty excreta" were removed by expiration. Most of the blood on reaching the right side of the heart passed through invisible pores in the septum. When the left ventricle dilated, air was sucked into it from the lungs and in the presence of the innate heat of the heart *vital spirits* were formed; this air also prevented the heat from becoming too great. The *vital spirits* were carried by the blood in the arteries by ebb and flow to and from all parts of the body to make possible the functions of the organs. On reaching the brain the *vital* generated the *animal spirits* which passed out along the nerves to bring about movement and sensation, etc. Leonardo da Vinci[26] (*fl.* 1500) distended the lungs with air and proved that none went directly into the pulmonary veins and thence into the heart; thus he was the first to question Galen's views. His drawings show how often he worked at the heart; he describes four chambers and recognized that the valves at the roots of the two great arteries prevented blood regurgitating into that organ and he seems to doubt that the blood

passed through the interventricular septum. It is difficult to say what influence he had upon those who followed immediately after him, for his drawings, which show flashes of a brilliant mind, remained unpublished for centuries.

Vesalius,[27] the father of modern anatomy, in the first edition of his "Fabrica" (1543) hinted that he doubted that the blood passed through the septum and in the second edition (1555)[28] states he could not find any channels from one ventricle to the other. Servetus[29] in the midst of his theological and heretical book "Christianismi restitutio" (1553), which caused his death, described the circulation of the blood through the lungs, or the lesser circulation. Servetus knew of the change of colour which the blood undergoes in the lungs but he had no conception of the heart as a pumping organ. The book may have been circulated in manuscript and have reached other scientific workers but this is doubtful and practically all copies of the printed word were burnt with him, only three being known to exist now. Realdus Columbus of Padua, whom Harvey refers to as "that skilful and learned anatomist,"[30]

in his "De re anatomica" (1559)[31] did not believe that the heart was a muscle but he denied the passage of blood through the septum. He described the lesser circulation and added that this fact had never been observed before or recorded; it is probable, then, that he was not acquainted with the book of Servetus of six years previous. Cesalpinus in his "Peripateticarum quaestionum" (1571)[32] and "Quaestionum medicarum" (1591)[33] wrote that in systole the heart sent blood into the aorta and on dilating, blood flowed into it from the vena cava. He was, it is true, the first to use the word "circulation" and he knew that when a ligature is tied, for the purpose of bleeding, the veins swell *beyond* it. He thought, however, that the heart was not a muscle and also that the septum was porous. Sir Michael Foster[34] says we must admit that he "clearly grasped the pulmonary circulation, but had also laid hold of the systemic circulation. . . . But the question may fairly be asked, How far were these views the outcome of patient research, of real study of the phenomena themselves? How far were they flung out in the spirit of controversy as effective assaults upon accepted doctrines?" And Foster is inclined to the

latter opinion. Only after years and years, not until after 1670, as Fraser Harris[35] has shown, were they disinterred, so to speak. Fabricius ab Aquapendente, like Vesalius, professor of anatomy at Padua, was, as we know, Harvey's teacher. In 1603 he published his book "De venarum ostiolis,"[36] on the valves of the veins, but he failed to see their true use, thinking they were merely to prevent all the blood from flowing in the veins to the feet or hands. He did not understand that these valves are so tight-fitting that they effectually prevent any blood flowing in a direction away from the heart. He was a good observer up to a point and Robert Boyle[37] related that it was these valves that made Harvey think hard about the movement of the blood, and first led him to investigate the subject.

Flourens[38] has given us an explanation of why progress was so slow towards the discovery of the circulation and we may use it as a sort of summary of our sketch of the history of the subject. Three errors in their theories stood in the way:

1. The arteries contained air.
2. The interventricular septum was perforated, and
3. The veins carried blood to the periphery.

V

THE MOVEMENT OF THE HEART

Harvey's book opens with a graceful dedication to Charles I in which a king as centre of the body politic is likened to the heart of man. Then an address to the President and physicians of the College follows, taking up about four pages. Harvey finds that true philosophers accept truth whencesoever it may come, "neither do they swear fealty to their mistress Antiquity, that they openly, and in sight of all, deny and desert their friend Truth."[39] He professes "both to learn and to teach anatomy, not from books but from dissections; not from the positions of philosophers but from the fabric of nature."[40] As if on second thought, a little shy and timid on account of his boldness in telling of his discovery, he closes with the phrase "Farewell, most worthy Doctors, and think kindly of your Anatomist, William Harvey."[41]

The book proper consists of an introduction of ten pages and seventeen chapters. The introduction tells of the older views of the vascular system, and I must quote

one sentence which goes far to remove one of the three obstacles referred to above: "Besides, if the blood could permeate the substance of the septum, or could be imbibed from the ventricles, what use were there for the coronary artery and vein, branches of which proceed to the septum itself, or supply it with nourishment?"[42]

Harvey's work is upon the motion of the heart and blood and I think we are inclined perhaps to remember that he dealt with the latter and to forget the former. He had such a sharp pair of eyes that he saw exactly what happens when the heart contracts and although he could not make this out at first in the heart of large warm-blooded animals, he went to toads, frogs, serpents, small fish, etc. where the movements were "slower and rarer." He saw that the heart was muscle and became paler when it squeezed the blood out of it. Let me quote an important paragraph:

> These things, therefore, happen together or at the same instant: the tension of the heart, the pulse of its apex, which is felt externally by its striking against the chest, the thickening of its parietes, and the forcible expulsion of the blood it contains by the constriction of its ventricles.[43]

He saw, too, that the auricles contract before the ventricles, driving the blood into the latter, that blood was forced out from the ventricles into the aorta and into the pulmonary artery, and that during diastole the heart was filled afresh. When he had gone so far, he knew that the heart was a pump, and he had gone a long way towards answering that great question which he had set himself. He noted further "in opposition to commonly received opinions" that "the arteries are filled and distended by the blood forced into them by the contraction of the ventricles; the arteries, therefore, are distended, because they are filled like sacs or bladders, and are not filled because they expand like bellows."[44] Observations of clinical cases were constantly drawn upon to support a thesis and in the case of an aneurism he writes that "the pulse in the corresponding arm was small, in consequence of the greater portion of the blood being diverted into the tumour and so intercepted;"[45] and perhaps he has described fibrillation of the auricles:

Besides this, however, I have occasionally observed, after the heart and even its right auricle had ceased pulsating,—when it was *in articulo mortis* in short, that an obscure

motion, an undulation or palpitation, remained in the blood itself, which was contained in the right auricle, this being apparent so long as it was imbued with heat and spirit.[46]

He likens the course of systole in the heart to what happens when the trigger of a flintlock is pressed:

These two motions, one of the ventricles, another of the auricles, take place consecutively, but in such a manner that there is a kind of harmony and rhythm preserved between them, the two concurring in such wise that but one motion is apparent, especially in the warmer blooded animals, in which the movements in question are rapid. Nor is this for any other reason than it is in a piece of machinery, in which, though one wheel gives motion to another, yet all the wheels seem to move simultaneously; or in that mechanical contrivance which is adapted to firearms, where the trigger being touched, down comes the flint, strikes the steel, elicits a spark, which falling among the powder, it is ignited, upon which the flame extends, enters the barrel, causes the explosion, propels the ball, and the mark is attained—all of which incidents, by reason of the celerity with which they happen, seem to take place in the twinkling of an eye.[47]

We now know that contraction starts in nodal tissue at the root of the vena cava

but we could not express the sequence of events more picturesquely.

Harvey tells us why anatomists before his time did not learn the true nature of things as he did:

> Had anatomists only been as conversant with the dissection of the lower animals as they are with that of the human body, the matters that have hitherto kept them in a perplexity of doubt would, in my opinion, have met them freed from every kind of difficulty.[48]

But surely he is more than charitable, for even if they had examined lower animals, they would not have had Harvey's eye and brain!

VI

THE CIRCULATION

We now reach the eighth chapter where, as on folio 80 verso of his "Prelectiones," he puts into words his view of the nature of the movement of the blood. Vesalius before him had dared to stand up boldly against the authority of the masters of antiquity, especially Galen and Aristotle. It is hard for us to realize that before the revival of learning the authority of Aristotle had been sought in the schools of the West "from a Latin translation of a Hebrew translation of an Arab commentary upon an Arab translation of a Syriac translation of the Greek text."[49] Transmitted, dispersed and distorted as the light was in passing through these media, yet it was almost worshipped for centuries. Here are the feelings of Harvey as he dared to stand alone:

But what remains to be said upon the quantity and source of the blood which thus passes, is of so novel and unheard-of character, that I not only fear injury to myself from the envy of a few, but I tremble lest I have mankind at large for my enemies, so much doth wont and

custom, that become as another nature, and doctrine once sown and that hath struck deep root, and respect for antiquity influence all men: Still the die is cast, and my trust is in my love of truth, and the candour that inheres in cultivated minds. And sooth to say, when I surveyed my mass of evidence, whether derived from vivisections, and my various reflections on them, or from the ventricles of the heart and the vessels that enter into and issue from them, the symmetry and size of these conduits—for nature doing nothing in vain, would never have given them so large a relative size without a purpose,—or from the arrangement and intimate structure of the valves in particular, and of the other parts of the heart in general, with many things besides, I frequently and seriously bethought me, and long revolved in my mind, what might be the quantity of blood which was transmitted, in how short a time its passage might be effected, and the like; and not finding it possible that this could be supplied by the juices of the ingested aliment without the veins on the one hand becoming drained, and the arteries on the other getting ruptured through the excessive charge of blood, unless the blood should somehow find its way from the arteries into the veins, and so return to the right side of the heart; I began to think whether there might not be A MOTION, AS IT WERE, IN A CIRCLE. Now this I afterwards found to be

true; and I finally saw that the blood, forced by the action of the left ventricle into the arteries, was distributed to the body at large, and its several parts, in the same manner as it is sent through the lungs, impelled by the right ventricle into the pulmonary artery, and that it then passed through the veins and along the vena cava, and so round to the left ventricle in the manner already indicated.[50]

And yet the burden of the Stagyrite's authority was still upon him for immediately afterwards he returns to him:

Which motion we may be allowed to call circular, in the same way as Aristotle says that the air and the rain emulate the circular motion of the superior bodies; for the moist earth, warmed by the sun, evaporates; the vapours drawn upwards are condensed, and descending in the form of rain, moisten the earth again; and by this arrangement are generations of living things produced; and in like manner too are tempests and meteors engendered by the circular motion, and by the approach and recession of the sun.

And so, in all likelihood, does it come to pass in the body, through the motion of the blood; the various parts are nourished, cherished, quickened by the warmer, more perfect, vaporous, spirituous, and, as I may say, alimentive blood; which, on the contrary, in contact

with these parts becomes cooled, coagulated, and, so to speak, effete; whence it returns to its sovereign the heart, as if to its source, or to the inmost home of the body, there to recover its state of excellence or perfection. Here it resumes its due fluidity and receives an infusion of natural heat—powerful, fervid, a kind of treasury of life, and is impregnated with spirits, and it might be said with balsam; and thence it is again dispersed; and all this depends on the motion and action of the heart.

The heart, consequently, is the beginning of life; the sun of the microcosm, even as the sun in his turn might well be designated the heart of the world; for it is the heart by whose virtue and pulse the blood is moved, perfected, made apt to nourish, and is preserved from corruption and coagulation; it is the household divinity which, discharging its function, nourishes, cherishes, quickens the whole body, and is indeed the foundation of life, the source of all action. But of these things we shall speak more opportunely when we come to speculate upon the final cause of this motion of the heart.[51]

As John G. Curtis[52] has pointed out, Harvey again and again in this book returns to the question of the physiological primacy of the heart versus the primacy of the blood, as he does in his "Prelectiones,"

and in that on the "Generation of Animals." Sometimes for him, as with Aristotle, the heart is primary, and sometimes the blood, harking back to a Greek doctrine older than Aristotle himself, regarding it as the very seat of the soul. For Harvey, the heart beat is caused by the swelling of hot blood, but if this were so, how does he explain that the empty heart may contract as he observed? He does not recognize the sucking action of the dilating chambers of the heart. Respiration was a knotty point for Harvey and he ends "with a practical confession of ignorance." He states, "it is no less plain why the blood of the lungs is so ruddy; for it is thinner, because there it has filtered through."[53] And in his old age he questions, if he does not deny, the cooling effects of respiration. There is a marginal note, too, in his "Prelectiones:" "Why and how air is needed by animals which breathe and also air is necessary to a candle and to fire see WH."[54] This question might have been taken up in his promised treatise on respiration. He also did not see that respiratory movements were an aid to the circulation.

All this does not take away from his power as an observer, but as a speculator

we might liken him to those who preceded him in physiology by two thousand years. He went as far as scientific conditions of his time allowed and are we not today still limited in outlook? Harvey was as conscious of this as we are and later wrote in a letter to John Daniel Horst: ". . . nor do I doubt but that many things still lie hidden in Democritus's well that are destined to be drawn into the light by the indefatiguable diligence of coming ages."[55]

VII

FURTHER PROOFS

Harvey proceeds in the ninth chapter to show and to measure the amount of blood the left ventricle would hold. And assuming that only a fourth, a sixth, or an eighth part of it is sent out into the aorta with each beat of the heart and multiplying the smallest of these fractions, say one drachm, by the number of heart-beats in half an hour we find that during that time more blood has passed out of the heart than can be accounted for by all the blood in the whole body. And again reckoning the amount of blood sent out by the heart in the course of a day, it is found that it cannot be accounted for by all the food ingested. "In short," he says in this masterful chapter, "it could be furnished in no other way than by making a circuit and returning."[56] As further proof of a circulation, Harvey points out that:

> Butchers are well aware of the fact and can bear witness to it, for, cutting the throat of an ox and so dividing the vessels of the neck, in less than a quarter of an hour they have all the vessels bloodless—the whole mass of blood has escaped.[57]

And Harvey shows, if only an artery of an animal is cut, how quickly both veins and arteries are completely emptied.

Thus we see, as Huxley[58] pointed out, that this book, "contains the first application of quantitative considerations to a physiological problem." And we are reminded of Lord Kelvin's[59] view on the quantitative method in science:

> Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than looking for something new. Yet nearly all the grandest discoveries of science have been the rewards of accurate measurement and patient, long-continued labour in the minute sifting of numerical results.

Harvey's view of the circulation from heart, to artery, to vein, to heart is confirmed again in another passage:

> If a live snake be laid open, the heart will be seen pulsating quietly, distinctly, for more than an hour, moving like a worm, contracting in its longitudinal dimensions (for it is of an oblong shape), and propelling its contents; becoming a paler colour in the systole, of a deeper tint in the diastole; and almost all things else by which I have already said that the truth I contend for is established, only that here everything takes place more slowly,

and is more distinct. This point in particular may be observed more clearly than the noon-day sun: the vena cava enters the heart at its lower part, the artery quits it at the superior part; the vein being now seized either with forceps or between the finger and thumb, and the course of the blood for some space below the heart interrupted, you will perceive the part that intervenes between the fingers and the heart almost immediately to become empty, the blood being exhausted by the action of the heart; at the same time the heart will become of a much paler colour, even in its state of dilatation, than it was before; it is also smaller than at first, from wanting blood; and then it begins to beat more slowly, so that it seems at length as if it were about to die. But the impediment to the flow of blood being removed, instantly the colour and the size of the heart are restored.

If, on the contrary, the artery instead of the vein be compressed or tied, you will observe the part between the obstacle and the heart, and the heart itself, to become inordinately distended, to assume a deep purple or even livid colour, and at length to be so much oppressed with blood that you will believe it about to be choked; but the obstacle removed, all things immediately return to their pristine state—the heart to its colour, size, stroke, &c.[60]

He now turns to what was known implicitly but not explicitly before by those who

applied ligatures, the uses of these and fillets tied about the limbs in bleeding being explained. He shows how ligatures may be employed to stop hemorrhage and again to induce sloughing and more extensive mortification in castration or in the removal of warts and fleshy tumours. And he notes the different effects found by applying tight or "middling" ligatures to the limbs, the former cutting off the pulse of the arteries, the latter blocking the flow in the veins; and how on loosening a tight ligature the pulse may again be felt distal to it and on loosening a "middling" one, the tumidity of the veins beyond it vanishes and the part regains its normal colour.

One portrait of Harvey,[61] but it is doubtful if it is a contemporary one, shows that he possessed a microscope of the compound type as was pointed out to Sir Frederick Andrewes[62] and mentioned in his Harveian Oration of 1920; but Harvey makes no mention of it and if it had been of great service to him we should think he would have said so. He did not see capillaries, denied the form of anastomoses of Galen, and believed that the blood passed through frequent porosities (*porositates*).

The London bookseller Nock,[63] in opposition to Willis, held that by *porositates* Harvey meant "walled channels." He knew the passages of arteries to veins must be numerous for with a "middling" ligature or fillet applied above the elbow, "if any single small vein be pricked with a lancet, they all speedily shrink, disburthenning themselves into this they subside almost simultaneously."[64] It remained for Malpighi, born in the very year that Harvey's great work appeared, to supply the missing element in the investigations of Harvey, for in his book "Observationes anatomicae de pulmonibus"[65] published in 1661 he described how he saw the capillaries of the lesser or pulmonary circulation. In 1688 Leeuwenhoek[66] not only observed the systemic capillary circulation but also saw the blood corpuscles actually passing through the tiny capillaries.

In the thirteenth chapter Harvey shows the true use of the valves in veins and here his book has two plates. He applied a middling fillet just above the elbow whereby the veins were distended and the sites of the valves rendered visible. By placing the finger on a vein just above one knot made by a valve and emptying a

small portion of vein above this with another finger he showed that blood could be pushed beyond the next valve above but would not flow back, and could not be made to flow back again, below it. The vein between the upper valve and the finger applied on the vein below remained flat and empty. But if the finger was taken away from the vein just above the lower valve, blood from the hand immediately flowed up into the empty portion of the vessel. These and other like observations of Harvey prove conclusively the functions of the valves. Harvey is also aware of the help given by motion of the extremities and contraction of the muscles in aiding the return of blood through the veins.

In the sixteenth chapter Harvey, as he says, proves the circulation of the blood by other consequences. He saw that the whole system was contaminated by "contagions," poisoned wounds, bites of serpents and rabid animals, lues venerea, etc., and also:

When we perceive, further, that medicines applied externally exert their influence on the body just as if they had been taken internally, the truth we are contending for is confirmed. Colocynth and aloes (applied externally) move

the belly, cantharides excites the urine, garlic applied to the soles of the feet assists expectoration, cordials strength, and an infinite number of examples of the same kind might be cited.[67]

He describes, too, how many problems may be solved once the theory of the circulation is accepted:

Finally, reflecting on every part of medicine, physiology, pathology, semeiotics, therapeutics, when I see how many questions can be answered, how many doubts resolved, how much obscurity illustrated, by the truth we have declared, the light we have made to shine, I see a field of such vast extent in which I might proceed so far, and expatiate so widely, that this my tractate would not only swell out into a volume, which was beyond my purpose, but my whole life, perchance, would not suffice for its completion.[68]

In his epistle to Riolan, Harvey[69] shows, he cannot accept the view of Asseli who discovered the lacteals of the mesentery in 1622. Here it is interesting to quote a characteristic passage from Sir William Osler's Harveian Oration "The Growth of Truth" (1906):

How eminent soever a man may become in science, he is very apt to carry with him errors

which were in vogue when he was young—errors that darken his understanding, and make him incapable of accepting even the most obvious truths. It is a great consolation to know that even Harvey came within the range of this law—in the matter of the lymphatic system—it is the most human touch in his career.[70]

It was through one of those ironies of fate that Harvey examined James Primrose in 1629 for entrance into the Royal College of Physicians and passed him, for the very next year the examinee[71] published his "Exercitationes, et animadversiones in librum, Gulielmi Harvaei de motu cordis et circulatione sanguinis," London, quarto. Examiners are prone to ask questions upon subjects in which they are themselves interested, as every student knows, and it is amusing to speculate whether Harvey drew Primrose out on aspects of the circulation which were uppermost in his own mind. At any rate Harvey disdained to take the slightest notice of this book, written it is true, by a pupil of Riolan. It has been said that this work by Primrose "appeals not once to experiment as a means of investigation."[72]*

VIII

TOUR ON THE CONTINENT AND RETURN TO LONDON

In July 1630 Harvey started out with the Duke of Lennox upon a tour through France. They were in Paris for some time but we have no record of Harvey's doings there; perhaps research in Paris might reveal some interesting details. In Paris Gui Patin referred to the followers of Harvey as the *circulateurs*;[73] this is playful but the Latin *circulator* means quack or charlatan. There is a letter in the Bodleian Library written by Harvey from France to Viscount Dorchester, Secretary of State, in which Harvey says that he hopes the rumour that his place at Court had been taken by another man is not true. One passage which shows that Harvey was still busy with his study of animals must be quoted. By the way, Harvey's hand is as difficult as ever:

the miseryes of the Cuntreyes we have passed & the hopes of our good success & all such news yo^{r} Hon: hath from better hands, I can only complayne, that by the waye we could scarce see a dogg crow kite Raven or any

bird, or any thinge to anatomise only sum few miserable people the reliques of the war & the plauge [*sic*] where famine had made anatomies before I came. it is scarce credible in soe ritch, populous & plentifull cuntryes as these weare that soe much misery desolation & poverty & famine should in soe short a time be, as we have seen. I interpret it well, y^{t} wilbe a greate motive for all heare to have & pcure an assurance of a setled peace. it is time to leave fighting when, ther is nothing to eate nothing to be kept & gotten & the same partyes robb on the other if they gett but once out of sight

Y^{r} Hon:
Humble servant
Will. Harvey.[74]

This shows, too, that he was well aware of what went on in the political world for the Mantuan war ceased not long after.

The Duke's party visited Blois amongst other places and I like to think that Harvey made a pious pilgrimage to Ambois not far off, where Leonardo had died in 1519, but it is not likely that Harvey knew of him as a skilful anatomist. Nor is it probable that when they visited Spain Harvey thought of Servetus.

In 1633 Harvey accompanied Charles I on his journey to Scotland when the latter

was crowned at Holyrood. Harvey gives a very picturesque account, in his book on

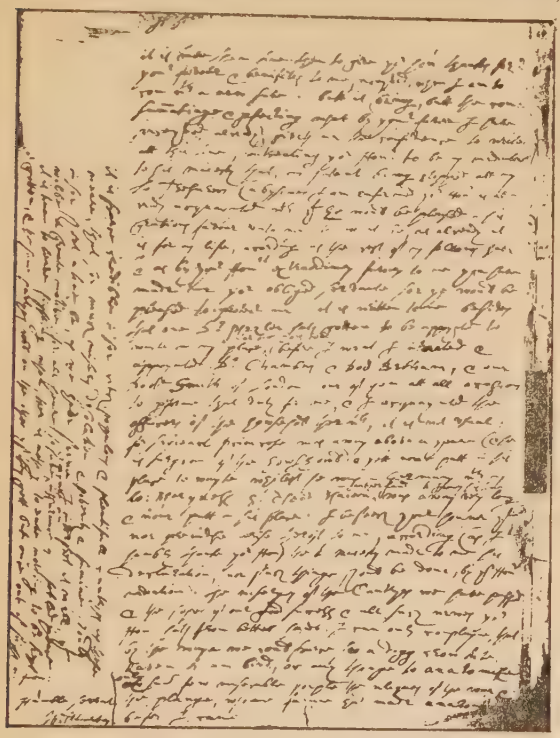

FIG. 7. Harvey's letter to Lord Dorchester.
(By permission of Bodley's Librarian.)

the generation of animals, of the gannets or Solon geese which covered Bass Rock,

an island in the Firth of Forth, and writes that he cannot believe that geese were generated from fruits of certain trees that had fallen into the sea.

By October of this year Harvey had returned to London and at a meeting of the President, Governors, the surgeons, and the apothecary of St. Bartholomew's Hospital he proposed "some particulars concerning the good of the poore of this howse and reformacon of some orders conceaved to be in this howse." I quote some of these suggestions which were adopted as proposed:

8. That the Chirurgions, in all difficult cases or where inward physic may be necessary, shall consult with the Doctor, at the times he sitteth once in the week and then the Master [i.e., the Surgeon] himself relate to the Doctor what he conceiveth of the cure and what he hath done therein. And in a decent and orderly manner proceed by the Doctor's directions for the good of the poor and credit of the house.

9. That no Chirurgion or his man do trepan the head, pierce the body, dismember [amputate], or do any great operation on the body of any but with the approbation and by the direction of the Doctor (when conveniently it may be had) and the Chirurgions shall think it needful to require.

15. That the Matron and Sisters shall signify and complain to the Doctor, or Apothecary in the Doctor's absence, if any poor lurk in the house and come not before the Doctor when he sitteth or taketh not his physic but cast it away and abuse it.

16. That the Apothecary keep secret and do not disclose what the Doctor prescribeth nor the prescriptions he useth but to such as in the Doctor's absence may supply his place and that with the Doctor's approbation.

On the other hand, another of Harvey's proposals was protested against by the surgeons. It was:

12. That every Chirurgion shall shew and declare unto the Doctor whensoever he shall in the presence of the patient require him, what he findeth and what he useth to every external malady; that so the Doctor being informed may better with judgment order his prescriptions.[75]

It would have been unfair to make the prescriptions of the surgeons public and not those of the physicians which were kept in a locked book, and guarded with jealous care as well.

IX

THE WITCHES—AN ANCIENT

Harvey in 1634 was concerned with a sad chapter of human deception (Osler),[76] but had it not been for him events might have been much sadder still. I refer to the affair of the Lancashire Witches. All the trouble arose through the story invented by a little boy of ten years, as he later confessed, to excuse himself when he had been at play instead of at school. His fairy tale of a dog being turned into a woman, another into a child, of the child into a horse, and of several witches in a barn would, we hope, have little credence now but it must be remembered that just the year before, in 1633, while Charles I and Harvey were in Scotland it was suspected that witches had had a hand in raising the great storm which caused such danger to the King at sea. As a result of the lad's tale seven women were thrown into gaol and three of these died. The Bishop of Chester, who examined them, evidently thought that intimate relations had existed between them and the Devil.

The women were brought to London to the "Shippe Taverne, Greenwich," and possibly at Harvey's suggestion the King ordered his two surgeons to choose some midwives and examine the suspected witches. The examination took place in Surgeons' Hall in Monkwell Street. Nothing extraordinary was found by the seven surgeons and ten midwives who signed the report, no excessive number of the organs which distinguish the mammalian from other animals. Harvey, apparently, was not present but it is recorded that the midwives were to be instructed by "Mr. Dr. Harvey." The lives of the four women were saved and we have nothing but praise for Harvey on this occasion, but it was not until 1720 that the last trial for witchcraft took place in England and not until 1735 that the Act of James I, under which proceedings were taken, was repealed. Even Sir Thomas Browne wrote of "the Dogs and Cats that usually speak unto Witches" and gave evidence at a trial in 1664, which helped to convict two women of witchcraft.[77]

Quite recently another story about Harvey and witches has been quoted again by Dr. Letitia Fairfield; it appeared in the

Gentlemen's Magazine for 1832 (part 1, 405–410) from an account presumably written about 1685. It is later printed also in Professor Notestein's[78] "History of English Witchcraft:"

It is easy in discussing the Lancashire affair to miss a central figure. Frances Dickson, Mary Spencer, and the others, could they have known it, owed their lives in all probability to the intellectual independence of William Harvey. There is a precious story about Harvey in an old manuscript by an unknown writer, that, if trustworthy, throws a light on the physician's conduct of the case. The letter seems to have been written by a justice of the peace in Southwestern England about 1685. He had had some experience with witches, and he was prompted by them to tell a story of Dr. Harvey, with whom he was very familiarly acquainted. "I once asked him what was his opinion concerning witchcraft; whether there was any such thing. Hee told mee, he believed there was not." Asked the reasons for his doubt, Harvey told him that "when he was at Newmarket with the King (Charles 1) he heard there was a woman who dwelt at a lone house on the borders of the Heath who was reputed a witch; that he went alone to her and found her alone at home . . . . Hee said shee was very distrustful

Exercitatio Anatomica

De

CIRCULATIONE SANGUINIS.

Ad *Joannem Riolanum* filium *Parisiensem*; medicum peritissimum Anatomicorũ Coryphæum; in Academia *Parisiensi* Anatomes & Herbariæ Professorem Regium & egregium atque Decanum, Reginæ matris Lodovici XIII medicum primarium.

Authore,

GULIELMO HARVEO Anglo, in Collegio Medicorum *Londinensium* Anatomes & Chirurgiæ Professore; sereni simæque Majestati Regio Archiatro.

CANTABRIGIÆ,
Ex officina *Rogeri Danielis*, almæ Academiæ Typographi.
1649.
Prostant venales prope ostiolum Boreale *Templi Divi Pauli*, LONDINI.

FIG. 8. Title-page of the first edition of Harvey's other work on the circulation.
(Reproduced by permission of the University of Nebraska.)

at first, but when hee told her he was a wizard, and came purposely to converse with her on their common trade, then shee easily believed him; for say'd hee to me, 'You know I have a very magicall face!' " The physician asked her where her familiar was and desired to see him, upon which she brought out a dish of milk and made a chuckling noise as toads do, at which a toad came from under the chest and drank some of the milk.

Harvey now laid a plan to get rid of the woman. He suggested that as fellow witches they ought to drink together and that she procure some ale. She went out to a neighboring ale-house, half a mile away, and Harvey availed himself of her absence to take up the toad and cut it open. Out came the milk. On a thorough examination he concluded that the toad "no ways differed from other toades," but that the melancholy old woman had brought it home some evening and had tamed it by feeding and had so come to believe it a spirit and her familiar. When the woman returned and found her "familiar" cut in pieces, she "flew like a Tigress" at his face. The physician offered her money and tried to persuade her that her familiar was nothing more than a toad. When he found that this did not pacify her he took another tack and told her that he was the King's physician, sent to discover if she were a witch, and, in case she were, to have her apprehended.[79]

No date is given of this strange examination of a "familiar."

THOMAS PARR

Harvey's account of the post mortem he performed in 1635 on the body of Thomas Parr, who was reputed to have been one hundred and fifty-two years and nine months old, was published for the first time in Dr. Bett's "De ortu et natura sanguinis," London, 1669, octavo. "Old Parr" had been brought up from Shropshire to London by the Earl of Arundel to show the King as "a remarkable sight." I quote a passage in which Harvey tells why the old man died and also something of London Town at that time:

> The cause of death seemed fairly referrible [*sic*] to a sudden change in the non-naturals, the chief mischief being connected with the change of air, which through the whole course of life had been inhaled of perfect purity,—light, cool, and mobile, whereby the praecordia and lungs were more freely ventilated and cooled; but in this great advantage, in this grand cherisher of life this city is especially destitute; a city whose grand characteristic is an immense concourse of men and animals, and where ditches abound, and filth and offal lie scattered about, to say nothing of the smoke engendered

by the general use of sulphurous coal as fuel, whereby the air is at all times rendered heavy, but much more so in the autumn than at any other season. Such an atmosphere could not have been found otherwise than insalubrious to one coming from the open, sunny and healthy region of Salop; it must have been especially so to one already aged and infirm.

And then for one hitherto used to live on food unvaried in kind, and very simple in its nature, to be set at a table loaded with variety of viands, and tempted not only to eat more than wont, but to partake of strong drink, it must needs fall out that the functions of all the natural organs would become deranged. Whence the stomach at length failing, and the excretions long retained, the work of concoction proceeding languidly, the liver getting loaded, the blood stagnating in the veins, the spirits frozen, the heart, the source of life, oppressed, the lungs infarcted, and made impervious to the ambient air, the general habit rendered more compact, so that it could no longer exhale or perspire—no wonder that the soul, little content with such a prison, took its flight.[80]

X

ANOTHER CONTINENTAL TOUR

Possibly the Earl of Arundel and Harvey met for the first time through this incident of Parr's visit to London; at any rate "Dr. Harvey" became the Earl's physician and was chosen to accompany the diplomatic mission when the Earl was sent to Vienna by Charles I as Ambassador Extraordinary to the Emperor Ferdinand II "in the final stage of the Palatinate discussion." The Earl of Arundel had very artistic tastes and so had Charles I; Basil Feilding, later second Earl of Denbigh, was already in Venice nominally as English Ambassador but in reality to collect works of art, and the Rev. William Petty was in Florence on the same errand for the Earl of Arundel. Harvey appears in a new light as an amateur of art through the discovery in 1911 of some precious letters written by him to Feilding, which have been purchased and presented to the Royal College of Physicians, the gift of Sir Thomas Barlow.

The mission started out in April 1636, visited Holland, travelled up the Rhine,

and finally down the Danube to Linz where the visitors were received by the Emperor and Empress. The Earl of Arundel said jokingly that "honest little Doctor Harvey meant to convert" the Jesuits at Cologne. Honest little Dr. Harvey, as the Earl described him, was fifty-eight years old by this time but was still in search of specimens, it being said of him, " . . . he would still be making observations of strange trees and plants, earths, etc., and sometimes he was like to be lost, so that my Lord Ambassador would be really angry with him for there was not only danger of thieves but also of wild beasts."[81]

Caspar Hofmann, then Professor of Medicine at Nuremberg, had not received the new doctrine of the circulation in its entirety, so Harvey wrote asking that he have the opportunity of making a demonstration, pointing out that he did not wish Hofmann to "derogate from the faith of an honest man, not altogether foolish or insane, who has had experience in such matters for a long series of years."[82] The public dissection, in the presence of Hofmann on Harvey's return trip, was convincing to everyone but the man for whom it was intended. It is said that Hof-

Fig. 9. Frontispiece of the first edition (London, 1651). Actual size 20 cm. × 15.5 cm.

mann continued in his objections, so Harvey finally threw down his knife and left the theatre.

A passage in one of Harvey's letters from Linz must not be omitted:

> Yesterday my lord was feasted by the nobility att the house of the Count of Milan, the cheife major-domo of his Majestie. We drunk hard, and had many expressions and many good wishes. What will succeed is of noe [*sic*] less expectation and consequences than our desires are to know it.[83]

At Augsburg on the return from Vienna and Prague, Harvey left the mission, setting out on horseback for Venice with two attendants. Alas! He did not reach the town, but on account of fear of the plague, was put into quarantine at Treviso, eighteen miles from his goal. There are several letters beseeching Lord Feilding to have him released of which I quote the first which reads as follows:

> 1638, Aug. 3–13. Treviso.—My sweete lord, I came this morning to the gates of Treviso with greate joy, and hoped this night to have had the happiness to have beene with you att Venice, butt I have receyved heare a very unjust affront, being stayed and commanded

by this podesta to have gone into the lazaretto, without any cause or suspition alledged. I tooke my first *fede* [certificate of health] under the seale of Ratisbone, a place free, and now destined, as your Eccellency knoweth, for the meeting of the Emperor and all the rest of the princes, which yf it had not beene soe, they would not have com thither, it being infected or suspected. Since, in every place as I came, I caused my *fede* to be underwritten, soe that there is no ground for them to lay any suspition upon me. And att this sentence on me by the podesta (that I should goe to the Lazarett) I absolutely refused, and sayd and offered to shewe that I had the pass and recommendation of his Majesty the King of Greate Brittane and of the Emperors Majesty and of my lord Embassador his Excellency, and that I had to goe to princes and men of quality, and that my business required expedition, and desier'd they would not hinder me, butt, as my passes required, further me and that I mought not bring that suspition and infamy on me, besides my own security, to goe to such a place as lazaretto, whear they use to putt infected persons, and that I had shewed them sufficient *fede*. Notwithstanding all this, heare I am to lye for ought I see in the open base [*sic*] feilds, God knows how long. The podesta refuseth to see or reade my passes, and I cannot cum att him to speake and use my reasons. I am afrayed this lying in the feild will doe me hurt

FIG. 10. Engraved title of the Elzevir (1651) edition with London imprint. Other copies have Amsterdam imprint. Note the motto on the egg. Actual size 11.3 cm. × 6 cm.

in my health. I beseech your Eccellency to lament hearof. It is unjust to proceed with any man thus without cause and otherwise then Venetians are used in England or soe merit to be used heare, and otherwise then is fitting for the respects there shold be used to the passes forenamed.

I pray pardon this scribling on the grass in the feild, and procure with all expedition my freedom from this barbarous usadg. Your distressed frend and humble servant of your Eccellency.[84]

Still nothing was done except the authorities offered to improve his quarters a little, but Harvey thought that was "unseasonable like phisick when a man was ded"[85] and refused to change his lodging. After having been there for about a week, Harvey writes "I have a sciatique in my right thigh and legg that much discorageth me, and maketh me lame."[86] We do not know how long he was in quarantine but the last of a number of letters from Treviso in the same strain was dated August 16–26. The next one is from Florence and we find that Harvey's spirits had revived for he had been entertained quite magnificently by Ferdinand II, Grand Duke of Tuscany from 1620–1670, the

lover of science under whose patronage the Accademia del Cimento was founded in 1657 even before the Royal Society and the Académie des Sciences at Paris.

The Earl of Arundel had become worried about Harvey and wrote to the Rev. William Petty at Florence making inquiries and saying quite affectionately: "I do hope I shal see the little perpetual mov[ement] called Dr. Hervye here before my go[ing]."[87] And does not that phrase describe the man whose active mind in an active body gave birth to the idea of the movement of the heart and blood? The Pilgrims' book of the English College at Rome shows that Harvey dined there on the 5th of October with another Kentish man, also an M.D. of Padua, Dr. Ent. Early in November Harvey had rejoined the party at Ratisbon and shortly afterwards they returned to London.

XI

CIVIL WAR, OXFORD, LONDON

In 1642 Parliament prepared for war against the King and during the summer there was a certain amount of lawlessness from which Harvey suffered grievously for his official lodgings in Whitehall were entered, and he writes:

> Let gentle minds forgive me, if recalling the irreparable injuries I have suffered, I here give vent to a sigh. This is the cause of my sorrow:—Whilst in attendance on His Majesty the King during our late troubles, and more than civil wars, not only with the permission but by the command of the Parliament, certain rapacious hands not only stripped my house of all its furniture, but, what is a subject of far greater regret to me, my enemies abstracted from my museum the fruits of many years of toil. Whence it has come to pass that many observations, particularly on the generation of insects, have perished with detriment, I venture to say, to the republic of letters.[88]

The lost books of Galen, I believe, are not so much missed as are these writings of Harvey.

Harvey left London with the King and we know from a manuscript in the hand of

Dr. Percival Willoughby that he visited the latter at Derby. In the course of a gynecological talk he described a rare form of cancer which he called "honey-comb,"[89] forgotten until 1920 when Dr. H. R. Spencer described a case in his Lettsomian Lectures.[90] Listen to Willoughby's words in praise of Harvey whom we should venerate as the father of modern midwifery as we have of modern physiology:

> I know none but Dr. Harvey's directions, and method, the which I wish all midwives to observe, and follow and oft read ouer [*sic*] and ouer again and in so doing they will better obserue [*sic*] and understand and remember the sayings and doings of that most worthy, good and learned D^r^ whose memory ought to bee had for euer [*sic*] in great esteem with midwiues [*sic*] and child bearing women.[91]

Harvey was at the battle of Edgehill not far from Oxford in October 1642, in charge of the two little princes. It is said that he read a book under a hedge until things grew too hot for him, and he began his work of dressing wounds. After the battle the King took up his residence in Oxford, Harvey accompanying him, where they remained during the siege. It is difficult to think that Harvey did not join with

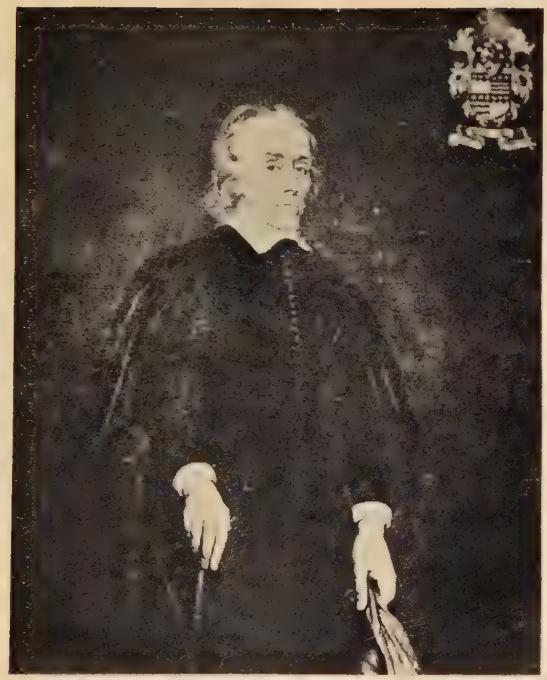

FIG. 11. Portrait (? by Van Dyck) now owned by Mrs. Franck Carr. (From "Portraits of Dr. William Harvey," London, Oxford University Press, 1913.)

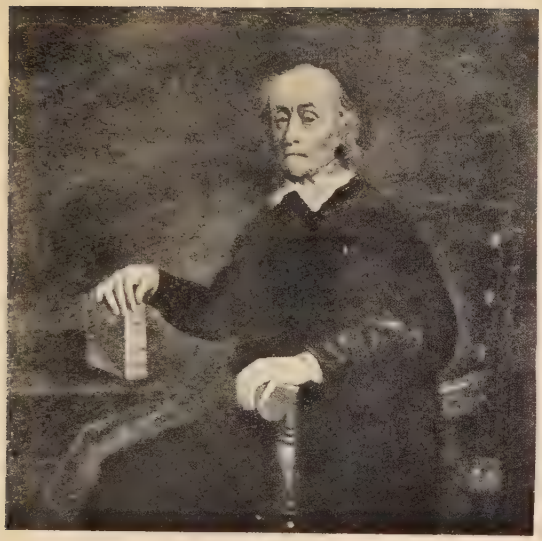

FIG. 12. Portrait (by Jansen) at the Kent and Canterbury Hospital. (From H. R. Spencer's "Harveian Oration," London, Harrison & Sons, 1921.)

Wallis, Seth Ward, Bathurst, Willis, Petty and others who made up the "Philosophical" or "Invisible College." They had had to leave London for Oxford, but some years later, after returning, they founded the Royal Society. No record has been found of Harvey's presence at these meetings but he certainly carried on dissections in Oxford and observed the development of the chick with Bathurst in the latter's rooms. Harvey was also very kind to young Charles Scarburgh, took him into his apartment and said: "Prithee, leave off the gunning and stay here; I will bring thee into practice."[92] Scarburgh took the advice, quenched his military ardour and later became physician to Charles II and James II and was knighted. Harvey was made an honorary M.D. of Oxford in 1645 and also Warden of Merton College through the King's influence, as Parliament had given his place to another man at St. Bartholomew's Hospital. I like to think of Harvey retiring to that beautiful library at Merton, perhaps to read and handle the "Continens" of Rhazes, printed at Brescia in 1486, which weighs 21½ pounds! Harvey could not have been troubled much by inquiring undergradu-

ates for during the siege there was "scarce the face of a University left." The town finally surrendered to the Parliamentary Forces in 1646 and King Charles escaped disguised as a servant.

Harvey returned to London and stayed with his brothers in turn. Riolan published his book "Encheiridium anatomicum et pathologicum" from Leyden in 1648 and his "Opuscula anatomica nova"[93] the following year in criticism of the circulation of the blood and in 1649 Harvey's "Disquisition"[94] in reply appeared from Cambridge. In this book Harvey says "I had much to put forth in my medical Observations and Pathology, which, so far as I know, has as yet been observed by no one," so it is likely he was producing another book. We also know he was busy with his work on generation and that each year he continued to deliver the Lumleian Lectures. In his old age he mastered Oughtred's "Clavis mathematica"[95] and worked away at its problems.

HARVEY'S ECCENTRICITIES

Eccentricities, the whims, and fancies of a great man, will always interest us; to

hear of them seems to bring us so much closer to him. "That he was humoursome and would sit down exactly at the time he had appointed dinner whether the company was come or not. That his saltcellar was always filled with sugar which he used to eat instead of salt."[96]

He was very fond of drinking coffee with his brother Eliab, before coffee houses were established and in his will he left his "coffy-pot" to a niece. "That he used to walk out in a morning combing his hair in the field."[96]

Aubrey writes of Harvey's gout:

> He was much and often troubled with the gout, and his way of cure was thus: He would sit with his legs bare, though it were frost, on the leads of Cockaine House, put them into a pail of water till he was almost dead with cold, then betake himself to his stove, and so 'twas gone.[97] [And of his disturbed sleep]: His thoughts working would many times keep him from sleeping, in which case his way was to rise from his bed and walk about his chamber in his shirt till he was pretty cool and then return to his bed and sleep very comfortably.[98]

Aubrey, for whose gossip we shall always be thankful, also says of Harvey, "He did delight to be in the dark, and told me he

could then best contemplate . . . whilst at the house at Combe in Surrey, he had caves made in the ground in which he delighted in summer-time to meditate."[99]

Would that we took more time for meditation!

XII

THE BOOK ON GENERATION

Charles I was beheaded in 1650 and Dr. Ent describes Harvey as he saw him about Christmas-time of that year:

> I found him, Democritus-like, busy with the study of natural things, his countenance cheerful, his mind serene, embracing all within its sphere. I forthwith saluted him and asked if all were well with him? "How can it be," said he, "whilst the Commonwealth is full of distractions, and I myself am still in the open sea? And truly," he continued, "did I not find solace in my studies, and a balm for my spirit in the memory of my observations of former years, I should feel little desire for longer life. But so it has been, that this life of obscurity, this vacation from public business, which causes tedium and disgust to so many, has proved a sovereign remedy to me." [100]

After Harvey had shown Ent his book on generation he was at length persuaded by the younger man that it should be published. Ent carried this work through and the passage I have quoted is from his dedicatory epistle addressed to the President and Fellows of the Royal College of Physicians.

The work, entitled "Exercitationes de Generatione Animalium. Quibus accedunt quaedam De Partu: de Membranis ac humoribus Uteri: & de Conceptione," was published by Pulleyn, in St. Paul's Churchyard, London, 1651, quarto, and three other editions appeared from Amsterdam in the same year. The frontispiece of the London, and the engraved title of one of the Amsterdam editions bear the motto *Ex ovo omnia*, all animals are produced out of ova, which gives the key to Harvey's view on generation and development. Like Aristotle, whom he delights to call "the Philosopher," Harvey believed in epigenesis, that the organs of the embryo arise by new formation and not by mere enlargement of a preexisting condition. Under Harvey's guidance we can make out what can be seen by the naked eye or magnifying glass of changes day by day in the development of the hen's egg and we learn what the exercise of trained powers of observation can tell us of the habits of fowls and animals, especially deer, which he studied in Windsor Forest, and of the structure and function of the parts as revealed by careful dissection. In his introduction Harvey writes, "And truly in such pursuits

Fig. 13. Hempstead Church.
(From Sir B. W. Richardson's "Disciples of Aesculapius," N. Y., E. P. Dutton & Co., 1901.)

it is sweet not merely to toil, but even to grow weary, when the pains of discovery are amply compensated by the pleasures of discovery."

There are passages in this work worth recording which show us how familiar Harvey was with the hunting parties of his royal Master and with the ways and days of country folk. These are descriptions which stir the blood with their beauty and vividness, especially when he tells us of the shepherd that knows every one of his sheep and to which ewe each lamb belongs. I cannot resist a quotation:

. . . there are some who, in hunting, when there are some forty hounds upon the trace of the game and all are giving tongue together, will nevertheless, and from a distance, tell which dog is at the head of the pack, which at the tail, which chases on the hot scent, which is running off at fault; whether the game is still running or is at bay; whether the stag has run far, or has but just been raised from his lair. And all this amid the din of dogs, and men, and horns, and surrounded by an unknown and gloomy wood. We should not, therefore, be greatly surprised when we see those who have experience telling by what hen each particular egg in a number has been laid. I wish there

were some equally ready way from the child of knowing the true father.[101]

He recognized one of the hard laws of Nature; who has expressed it better?

The eternity of things is connected with the reciprocal interchange of generation and decay; and as the sun, now in the east and then in the west, completes the measure of time by his ceaseless revolutions, so are the fleeting things of mortal existence made eternal through incessant change, and kinds and species are perpetuated though individuals die.[102]

He refers to Parisanus, one of the men who criticized the doctrine of the circulation and one who believed that the liver was "the author and fashioner of the blood." Listen how playfully he refers to his critics: "Among the number of modern abettors of such views, Parisanus has of late with confidence enough, but little skill, been singing to the old measure."[103] It was with pardonable pride that he was able to write: "The admirable circulation of the blood originally discovered by me, I have lived to see admitted by almost all; nor has aught as yet been urged against it by anyone which has seemed greatly to require an answer."[104]

He did not enunciate Agassiz's law, but knew that the embryo developed through stages which might be likened to the adult stages of the lower animals, namely, in a human embryo of the second month ". . . in shape like a little frog . . . The face was the same as that of the embryo of one of lower animals—the dog or cat, for instance, without lips, the mouth gaping, and extending from ear to ear." In the human embryo of the fourth month he noted that: "The intestinum coecum, that appendix of the colon, was empty as in the adult, and apparently superfluous, not as in the lower animals—the hog, horse, hare, constituting as it were another stomach."[105]

Although he likens man to animals, listen to how he tells of the differences between them and of how man was able to rise above the lower creatures:

> Man comes into the world naked and unarmed, as if nature had destined him for a social creature, and ordained him to live under equitable laws and in peace; as if she had desired that he should be guided by reason rather than be driven by force; therefore did she endow him with understanding, and furnish him with hands, that he might contrive

what was necessary to his clothing and protection. To those animals to which nature has given vast strength, she has also presented weapons in harmony with their powers; to those that are not thus vigorous, she has given ingenuity, cunning, and singular dexterity in avoiding injury.[106]

A passage a little farther on might make us think that we are reading out of Darwin's "Courtship of Animals" and he also depicts the survival of the fittest and the struggle for existence.

Harvey gives a number of practical pointers for gynecological and obstetrical practice, for instance, he realized that the symphysis pubis becomes loosened during the late stages of pregnancy, and also he invented a speculum for the giving of intrauterine injections.[107]

Harvey, however, was wrong in believing that efforts and movements of the fetus aid delivery.[108] Galen, centuries before, said that the fetus did not help by its movements and Fabricius,[109] Harvey's teacher, thought delivery was due to the force of gravity exerted upon the fetus.

One of Harvey's observations has been of the greatest medico-legal importance in determining whether a child was born alive or dead:

. . . when he observed that the lungs of foetuses which had breathed stretched and dilated by the air put on a whiter colour, and by this observation of the different complexion you may discover whether a mother brought her child alive or dead into the world; for instantly after inspiration the lungs change colour, which colour remains, though the foetus die immediately after.[110]

In his seventy-first and seventy-second exercises, at the end of that part of his book which deals with generation, Harvey discusses *calidum innatum*, or innate heat, and *humidum primigenium*, or radical moisture, because he felt that: "Many pride themselves upon the use of these terms, without . . . rightly understanding their meaning. There is, in fact, no occasion for searching after spirits foreign to, or distinct from, the blood."[111]

Harvey, as we see, endows the blood with wonderful properties. He could go so far and no farther, for Mayow had not yet appeared to tell of that part of the air necessary for both combustion and life which Priestley later prepared and Lavoisier called oxygen. In these last two chapters Harvey's philosophical discussions, harking back to Aristotle, sound

well-nigh unintelligible to us. Take for instance the paragraph:

> We must, therefore, make the distinction and say, that whilst no primary agent or prime efficient produces effects beyond its powers, every instrumental agent may exceed its own proper powers in action; for it acts not merely by its own virtue, but by the virtue of a superior efficient.[112]

We smile now, as others will do at our puerile efforts when looked at through the eyes of future ages, not realizing how far we are from answering the riddle of life.

XIII

HARVEY AND THE COLLEGE OF PHYSICIANS

So much for Harvey's work on generation, and we pass now to his later years. I was once lucky enough to come across a reference to Harvey in a letter written in December 1651 which is rather amusing when one thinks how difficult it would be for Harvey to operate upon himself. It is contained in a letter from John Finch to his sister, Anne Viscountess Conway:

> I was on Saturday with Sir Kenelme Digby where I had some philosophical Discourse; and he had heard of your marriage, but wondered with me at the story of Dr. Harvey; I must confesse I have scarce faith enough to believe [*sic*] that he would Cutt himselfe but rather beleive he voyded that stone you spoke of then cutt it out for I doe not see it was possible for him in two dayes to be able to goe abroad otherwise.[113]

It is the duty of us all to help our own medical libraries and knowing how widely read Harvey was and that he knew the value of the works of great authors we are not surprised that in 1630 he had

subscribed twenty pounds towards the purchase of a site and in 1632 had drawn up new rules for the library of the College of Physicians.[114] In July 1651, at an extraordinary *comitia*, the President of the College, Dr. Prujean, read out the following proposition:

> If I can procure one that will build us a library, and a repository for simples and rarities, such a one as shall be suitable and honorable to the College, will you assent to have it done, or no, and give me leave, and such others as I shall desire, to be the designers and overlookers of the work, both for conveniency and ornament?[115]

Of course this offer was accepted with alacrity and it is likely that the name of the anonymous donor was discovered, for the College voted the erection of a statue to Harvey which bore an inscription commemorating his epoch-making discovery of the circulation and his work upon generation. Unfortunately this statue was destroyed in the Great Fire of London in 1666. The College occupied a site at Amen Corner and Harvey's addition was built in the garden; Aubrey again comes forth with useful information: ". . . a noble building of Roman architecture (of

rustic work, with Corinthian pilasters), comprising a great parlour, a kind of convocation house for the fellows to meet in below, and a library above."[116]

Harvey not only gave the building but also books for the library and surgical instruments and curiosities for the museum. Perhaps the tanned human skin which he had presented in 1634 was deposited there. Although the building has long ceased to exist, the Librarian to this day is given the title, "Harveian." The library was opened on the 2nd of February 1653, when Harvey welcomed the College with a splendid feast and made over the title deeds.

Harvey was chosen President of the College in 1654 but was not present at the meeting. When approached, he declined the offer owing to old age and poor health, but his suggestion that Dr. Prujean be reelected was acted upon. Harvey continued his Lumleian Lectures until July 28, 1656, when he resigned, said good-bye to the Fellows and made over to the College forever his paternal estate of Burmarsh, Romney Marsh, Essex, which was then valued at fifty-six pounds a year. Harvey had three objects in view in this gift:

first, to establish an annual feast; second, to found an annual oration at which the benefactors of the College should be remembered, the Fellows and members of the College exhorted to study out the secrets of Nature by way of experiment, and, most important even for us of this day, they were to be urged to continue in love and affection amongst themselves; and third, to provide for a Librarian who would also have the museum under his care. The income from his estate was sufficient for the feast, a gratuity for the orator, and a salary for the Librarian. The first of these orations of which I can find note was delivered in 1656 by one Edward Emily[117] and up to 1865 they were always in Latin. At present they are held in the afternoon of St. Luke's Day on the 18th of October and in the evening the banquet takes place. Thus the memory of the great Harvey is kept green as one who was present on one of these occasions realizes full well, the benefactors are brought to mind, and at the dinner the Fellows meet convivially. The Library contains a wonderful collection of medical and other classics.

XIV

DEATH, BURIAL AND WILL

William Harvey died at Roehampton in the house of his brother Eliab on the 3rd of June, 1657, evidently of cerebral hemorrhage. He was buried at Hempstead in Essex about fifty miles from London, the funeral procession consisting of many Fellows of the College starting out on the 26th of June. The body was "lapt in lead" and, thus without a coffin, was laid in the vault beneath the "Harvey Chapel" which had been built by Eliab Harvey on the north side of the church. This tomb became ruinous and on St. Luke's Day, the 18th of October, 1883, his remains in the leaden case were placed in a white marble sarcophagus within the church. The President and twenty-six Fellows of the College were there, of whom that devoted disciple of Harvey, and later President of the College, Norman Moore, was the youngest.

Harvey's will,[118] in his own handwriting, was written between July 1651 and February 1652. It is a long, interesting document and remarkable for the number of

individual bequests to members of his own and of his wife's family and to his servants. The remainder of his lands were given to his "loving brother Eliab and his heirs."

He did not forget the College for which he had laboured so long:

Touching my bookes and householdstuffe Pictures and apparell of which I have not already disposed I give to the Colledge of Physicians all my bookes and papers and my best Persia long Carpet and my blue sattin imbroyedyed Cushion one paire of brasse Andirons with fireshovell and tongues of brasse for the ornament of the meeting roome I have erected for that purpose.[119]

The bequests to his two favourite young friends in the Profession are as follows:

Item I give my velvet gowne to my lo friend Mr Doctor Scarbrough desiring him and my lo friend Mr Doctor Ent to looke over those scattered remnant [*sic*] of my poore Librarie and what bookes papers or rare collections they shall thinke fit to present to the Colledge and the rest to be Sold and with the money buy better And for their paines I give to Mr Doctor Ent all the presses and shelves he please to make use of and five pounds to buy him a ring to keepe or weare in remembrance of me And to Doctor Scarbrough All my little silver instruments of surgerie.[120]

"By way of dessert"—to borrow a Harveian phrase—I make one more quotation, this time from the stone below the Master's bust in Hempstead Church.

William Harvey, at the mention of whose honourable name all academies rise up out of respect, who was the first after many thousand years to discover the circulation of the blood, and so brought health to the world and immortality to himself.[121]

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